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Study of Release of Hydrocarbon in the Atmosphere while LPG and Propane Tankers Loading and Its Occupational Health Effects

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Abstract— Hydro carbon is released in the atmosphere through rotogauge (Ref photo @) while loading of LPG and Propane in the tankers contributes occupational health problems to the workers, greenhouse gas effect (Ref $) as well as revenue loss though it is insignificant in case of one tanker but it is significant if we consider loading and unloading of tanker at National level per day and Organizational level per year. In order to overcome the problem of releasing of hydrocarbon through rotogauge (for measuring liquid level inside the tanker) it is necessary to study this topic in detail along with the effect of these hydrocarbons on the workers working in that area. To know the effect of released hydrocarbon on the loading operators their medical checkups were done in three different seasons. The result of the study will tell the effects of these hydrocarbons on operators, extent of energy loss and revenue loss as well as the method to minimize the loss of hydrocarbon in atmosphere during loading and unloading of tankers thereby limiting the exposure of the operators to hydrocarbon vapours.

Index Terms— Rotogauge, Occupational health, Hydrocarbon, Different seasons, Operators, Tankers

1 INTRODUCTION TO THE TOPIC

Rotogauge is a device which is used to measure the volumetric quantity of liquid level inside the pressurized container. The release of hydrocarbon from the rotogauge cannot be contained and is allowed to disperse in the atmosphere. (Ref #). In India Loading and unloading operation of the Liquefied Petroleum Gas (LPG) and Propane tanker is done with manual intervention to know the liquid level content inside the tank of the tanker lorry. Loading and unloading operation of Liquefied Petroleum Gas (LPG) and Propane tanker is carried out with intermittent checking of liquid level inside the tank with the help of rotogauge (Ref #). Rotogauge is a devise fitted in the tanker which is useful in measuring the liquid level inside the tanker in terms of percentage. In the present scenario the rotogauge helps to determine the liquid level inside the tank and liquid level inside the tank is ensured. (Maximum allowable liquid level is 95% and Vapour space of 5% is left) (Ref *).

Hydro carbon is released in the atmosphere through rotogauge (Ref photo @) while loading of LPG and Propane in the tankers contributes occupational health problems to the workers, greenhouse gas effect (Ref $) as well as revenue loss though it is insignificant in case of one tanker but it is significant if we consider loading and unloading of tanker at National level per day and Organizational level per year. In order to overcome the problem of releasing of hydrocarbon through rotogauge (for measuring liquid level inside the tanker) it is necessary to study this topic in detail along with the effect of these hydrocarbons on the workers working in that area. The photograph of releasing of LPG / Propane from rotogauge is given below –

(@)

2 STEPS USED IN THE RESEARCH

Photograph of Road tanker which is used for loading, unloading and transportation of LPG & Propane is given below

HYDRO CARBON TANKER WITH ROTOGAUGE

ROTOGAUGE

The study is designed at every stage keeping in view of the following objective

2.1 To study the filling mechanism of LPG as well as Propane tankers - Detail study is carried out regarding loading and unloading operation of LPG and Propane in the tankers at various locations of GAIL (India) Limited as well as other petroleum installations. Standard operating procedures are collected.

2.2 To estimate the quantum of hydro carbon released in atmosphere through rotogauge while checking the liquid level of hydrocarbon inside the tankers – Discharge rate of hydrocarbon (i.e. LPG and Propane) through 2 mm diameter size hole of rotogauge is determined theoretically with the help of software available (Ref ©) as well as same is crosschecked practically by collecting the discharge through rotogauge in the sampling balloon. The exact quantity of hydro carbon released through rotogauge is established for one tanker with the help of differential weight of sampling balloon. Data for number of LPG and Propane tankers loaded (at GAIL Vijaipur) during last three years is collected for calculating the quantity of unburnt LPG and Propane released in atmosphere.

2.3 To study the occupational health effect of VOC's (volatile organic compounds) on the loading operators who are involved in loading operations of these tankers over a period of different seasons.

2.4 Use of mathematical modeling to study the of the release of hydro carbon over a years with respect to occupational health effect due to exposure to the operator as well as on the organization economy.

2.5 To suggest the recommendations for overcoming the problem of release of LPG and Propane in atmosphere/application of technology

3 RESEARCH METHODOLOGY ADOPTED

3.1 THEORETICAL FRAMEWORK –

At present in India there are about 10,400 tankers (LPG + Propane) having valid license to carry / transport compressed hydrocarbon from Petroleum and Safety Organisation (formerly Chief Controller of Explosive). These tankers are being filled and emptied out regularly at different locations in India. All these tankers are having the liquid level measuring device called ROTOGAUGE. While filling as well as emptying out these tankers, the standard practice is to open the Rotogauge screw to check the level of tank in terms of volumetric percentage (Please see photographs of procedure displayed at loading gantry is enclosed). Particularly while filling the tankers, the liquid level content is being monitored at least three times by opening the Rotogauge (approximately hydrocarbon is being released in the atmosphere for total 1 minute through rotogauge). During opening the Rotogauge liquid hydrocarbon is coming out in the form of mist (containing liquid as well as vapours). While loading of these tankers, operator has to ensure that the liquid level of LPG / Propane inside the tanker should not exceed 95% (Ref *). For ensuring the same, operator fixed the rotogauge indicator at 95% mark, so that whenever liquid level reaches that mark, LPG / Propane in the liquid form starts coming out from the 2 mm diameter size orifice of rotogauge. Moreover while doing this measurement the operator is standing very near to the rotogauge device for operating it.

The proposed study is undertaken to see the occupational health effects on the loading workers due to inhalation of hydrocarbon mixed air, estimate the impact on greenhouse gas emission and revenue loss due to release of hydrocarbon in the atmosphere.

3.1 Source of Data

Data for study will be collected from various sources like –

3.1.1 Data collection for standard operating procedure for loading of tankers is taken from ISO manual of GAIL (India) Limited Vijaipur.

3.1.2 Visual inspection with photographs in support of confirming the loading procedure is taken from loading gantry of GAIL (India) Limited Vijaipur.

3.1.3 Quantity of hydrocarbon tankers (i.e. LPG and Propane only) is derived from the official web site of Petroleum and Safety Organisation (formerly Chief Controller of Explosives).

3.1.4 Material Safety Data sheets and contribution of unburnt hydrocarbon in greenhouse gas emission through various web sites.

3.1.5 Average price of industrial LPG and Propane is collected from GAIL's data bank.(through ERP-SAP)

3.1.6 Medical records of the sample loading operators having different years of experience and different age group.

4.0 Sampling

4.1 The data for the study is collected from existing standard operating procedures of loading activities.

4.2 Data pertaining to number of tankers state wise is taken from the official web site of the Petroleum and Safety Organisation (formerly Chief Controller of Explosives).

4.3 Crosschecking of the amount of LPG and Propane release in the atmosphere through 2 mm diameter rotogauge hole is done with the help of collecting the content in the sampling balloon and its differential weighment.

4.4 Survey is carried out for standard tanker loading practices in the other installation so as to determine the impact on health of workers as well as revenue loss at Organizational level on yearly basis.

4.5 Blood sample checking and clinical examination of the fixed workers of different age and different years of exposure.

5.0 Findings and Conclusion

The result of the study with respect to contribution of unburnt LPG and Propane (due to release from rotogauge) in occupational health effects on the workers, in greenhouse gas emission as well as revenue loss over a period of time is calculated and found that –

- Discharge rate of LPG from 2 mm diameter hole of rotogauge = 2.83 Lit / Min
- No of LPG tankers loaded at GAIL Vijaipur in the year 2011 = 9016
- Total amount of LPG discharge through rotogauge in the year 2011 at GAIL Vijaipur
  = 2.83 x 9016 = 25545.33 Lit
  = 25.54 m3 = 13.28 MT = 13280 Kg
- Calorific value of LPG = 55,000 KJ/Kg
- Energy loss for GAIL Vijaipur only for LPG for each year (say year 2011) = 13280 x 55,000
  = 73,04,00,000.00 KJ

The data for exposure of loading operators during three different seasons were measured. Area monitoring were done in three different seasons to know the level of various environment polluting parameters like SPM and Presence of Hydrocarbon traces and for the study total 15 loading operators (three groups of different age range i.e. 21 yrs – 30 yrs; 31 yrs – 40 yrs and 41 yrs – 50 yrs) were monitored for the following parameters –

- Blood cholesterol level
- Ergonomic postures while doing loading operations
- Various symptoms like cold, cough, headache, dizziness etc
- Habits while working
- Alertness of the operators

Based on the collected data it is concluded that –

1. **For Age group 21 yrs – 30 yrs**
   - Cholesterol level was found increased.
   - They were complaining regarding intermittent pain in the right side potion of their body particularly right groin and shoulder.
   - Teeth colour found change from White / off white to Reddish spots due to continuous chewing of tobacco or tobacco product.
   - Mild headache at the end of shift.

2. **For Age group 31 yrs – 40 yrs**
   - Cholesterol level was found increased including triglycerides.
   - They were complaining regarding pain in the right side potion of their body particularly right groin and shoulder during morning.
   - Teeth colour found change from White / off white to Reddish spots due to continuous chewing of tobacco or tobacco product.
   - Mild headache at the end of shift.
   - No sensation for ethyl mercaptan smell

3. For Age group 41 yrs – 50 yrs
   - Cholesterol level was found increased including triglycerides.
   - They were complaining regarding pain in the back and thigh muscles.
   - Teeth colour found change from White / off white to Reddish cum blackish spots due to continuous chewing of tobacco or tobacco product.

- Cold during morning.
- These age group operators suffered from fever 4 to 6 times during study may be due to deteriorating immune system.
- No sensation for ethyl mercaptan smell

Moreover it is also concluded from the data that all these symptoms aggravates during the winter season since level of hydrocarbon in the loading gantries are more than in summer and rainy season. The dispersion of the hydrocarbon vapours is found quick in summer and rainy season as compared to winter season.

6.0 Study of Literature

As far now with the best of information research in the same / similar field is not undertaken. Same is confirmed from NFSC, NCDC, DIFR, DGFASLI (Directorate General, Factory Advice Service and Labour Institutes) etc. However following literature is reviewed which is tabulated below with brief summary.

Sr No.	Themes	Author	Context	Inference
1	Greenhouse gas emission	Dr Lawrence Leung	International	Projection of fugitive greenhouse gas emission to 2020
2	Fuels and combustion	Bureau of energy efficiency	Indian	INTRODUCTION TO FUELS, PROPERTIES OF FUEL OIL, COAL AND GAS, STORAGE, HANDLING AND preparation of fuels, Principles of Combustion, Combustion of Oil, Coal, and Gas
3	METEOROLOGICAL DATA	Meteorological department	Indian	DATA WITH RESPECT TO TEMPERATURE, HUMIDITY, WIND SPEED AND WIND DIRECTION IN DIFFERENT SEASONS.
4	Energy sector overview	The international energy outlook 2005	Indian	RESERVE OF HYDROCARBON AND ITS CONSUMPTION PATTERN.
5	LPG tank truck incident	OISD GDN 161	Indian	GUIDELINES FOR HANDLING EMERGENCIES ARISING OUT OF LPG TANK TRUCK (TT) INCIDENTS
6	Composition of LPG		Indian	ENERGY NEED FOR INDIA
7	Design of tankers	Functional committee (OISD + PESO + Consultants)	Indian	DESIGN OF BULLETS ALONG WITH MATERIAL SPECIFICATIONS, FITTINGS, MOUNTING ETC FOR TRANSPORTATION OF LPG IN BULK BY ROAD
8	National energy map of India Technology vision 2030	TERI the energy resource institute and Office of Principal Scientific Advisor Government Of India.	Indian	Estimated energy demand. Production of primary sources of conventional energy in India.
9	Likely consequences of events on release of LPG	S S Gautam P K Saxena	Indian	Survey of criticality of risk from LPG storage tanks at user sites
10	Loading procedure of LPG road tankers	ISO manual	Indian	Detail procedure and operation of rotogauge
11	Loading procedure	GAIL (India)	Indian	Detail procedure for measuring the inside

	of LPG rail wagons	Limited		content.
12	Design layout of plants.	OISD GDN 144	Indian	Safety requirements on design, layout, storage, loading / unloading, operation, inspection & maintenance, fire protection, emergency planning and safety audit systems of LPG Installations.
13	Design aspects of tank lorries.	OISD GDN 151	Indian	Safety in design, fabrication and fittings of propane tank trucks
14	Handling of bulk petroleum gas	OISD GDN 158	Indian	Operation of equipment and facilities connected with storage and handling of LPG at Gas Processing Plants, Refineries and other Bulk Handling installations. Some basic concepts for design and construction of such facilities
15	Effect of VOC's	Klaus Abraham, Hans Mielke, Wilhelm Huisinga & Ursula Gundert-Remy	International	Elevated internal exposure of children in simulated acute inhalation of VOC's
16	LUNG FUNCTION AND BRONCHIAL REACTIVITY IN ASTHMATICS DURING EXPOSURE TO VOLATILE ORGANIC COMPOUNDS	Institute of Environment and Occupational Medicine, University of Aarhus, Aarhus, Denmark.	International	Study was to investigate whether vapors of organic solvents at low concentrations could exert an adverse effect in the lower airways. Under controlled conditions in a climate chamber
17	EFFECT OF LPG ON HUMAN BEING	US Department of health and human services	International	MSDS, monitoring and measurement procedures
18	EFFECT OF LPG ON HUMAN BEING	US Department of health and human services	International	MSDS, monitoring and measurement procedures
19	HAZARDS OF LPG	Major Hazard control by ILO	International	Fire, explosion and BLEVE conditions during release of LPG
20	CHEMICAL SAFETY	International program on chemical safety	International	Effect of LPG on environment and animals
21	CHEMICAL PROCESS SAFETY	Roy E Sanders	International	Various case studies are discussed
22	CHEMICAL PROCESS SAFETY	Danial A, Crowl, Joseph F, Louvar	International	Discussion on different source models

7. BIBLIOGRAPHY –

7.1 @ - Photographs taken during loading operation of LPG and Propane Tanker.

7.2 $ - http://en.wikipedia.org/wiki/Propane

7.3 * - OISD standard 159- LPG tank truck design / fabrication and fitting.
7.4 +- http://www.worldofmolecules.com/fuels/propane.htm
7.5 (¥) – http://www.cypenv.org/world/Files/methane.htm

7.6 (©) – http://www.mechengcalculations.com/index.html

7.7 # - Standard Loading procedure of LPG and Propane Tankers given in ISO:9001 Manual as well as displayed in the loading gantry at GAIL Vijaipur.

8. ABBREVIATIONS

LPG Liquefied Petroleum Gas

ISO International Standardization organization

GAIL Gas Authority of India Limited

OISD Oil Industry Safety Directorate

PESO Petroleum Explosive and Safety Organisation

CCOE Chief Controller of Explosives

PSV Pressure Safety Valve

VOC Volatile Organic compound

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